Title: **Production of Evergreen Shrubs in Paper Sludge-Amended Media**

Principal Investigator: **Robert R. Tripepi**
University of Idaho

Date: **January 12, 2001**

Report Series: **Final Report, January through July 2000**

Grant Agency & Amount: **NAC/ISDA 2000/2, $2,448**

CURRENT STATUS OF THE PROJECT

The final analyses for this experiment have been completed. Although the plants were grown in paper-sludge amended media during the 1999 growing season, research funds provided by the ISDA Nursery Advisory Committee in March 2000 were used to complete foliar analyses for the plants used in the study. To finish the project, we needed to determine bulk density of the potting mixes, determine the volume of shrinkage for the various media, and determine if the potting mixes affected plant growth rates during the study. Data for these three analyses are reported below, and an overall conclusion for the study is provided.

ABSTRACT

De-inked paper sludge from a newsprint mill was evaluated as a substitute for softwood bark in container media. Rooted cuttings of 'Youngstown' juniper (*Juniperus horizontalis*), Fraser photinia (*Photinia* x *fraseri*), 'PJM' rhododendron (*Rhododendron*), and Burkwood daphne (*Daphne* x *burkwoodii*) were planted in 3-liter plastic pots. The potting mixes used contained potting media amended with 0, 20, 40, 60, 80, or 90% paper sludge and 80, 60, 40, 20, 0, or 0%, respectively, bark (by volume). Initial chemical properties of the media, including pH, CEC, EC, C:N ratio and available P and K. After 19 weeks, plant heights were measured for photinia and rhododendron, but average plant width was measured for juniper. Shoot dry weights were also determined, and leaf samples were taken from all species to determine if the media affected nutrient content of the foliage. Bulk densities of newsprint sludge-sludge amended mixes were similar to the control mix, but the mix made with 90% paper sludge was about 38% lighter than the control medium that contained 80% bark (0% paper sludge). The volumes of potting mixes made with 60% or more paper sludge shrunk by 5% or more during the experiment. In fact, the volume of the 90% sludge mix shrunk by almost 13% during the 19-week study. The width of the 'Youngstown' junipers increased similarly for plants in all potting mixes except the 90% sludge mix, which grew the slowest. Photinia plants grown in 40% or less paper sludge grew at equal rates, but those in 60% or more sludge grew more slowly. Finally, rhododendron plants in the control mix (80% bark) grew the fastest, whereas those in 80% or more paper sludge media grew little if any. Daphne were excluded from all analyses in this

study since too many plants died during the experiment, and the foliar samples had to be pooled to have enough tissue for analyses. As reported previously, the results demonstrated that de-inked paper sludge could be substituted for up to 40% of the bark in a container medium for two of the three species tested. These new data showed that paper sludge media were light in weight, but they also shrunk, with the amount of shrinkage increasing as the volume of paper sludge used in the mix increased. In addition, the growth rate data also demonstrated that 'Youngstown' juniper and photinia could easily tolerate up to 40% newsprint sludge in the potting mix, but 'PJM' rhododendron plants were intolerant of media amended with newsprint sludge.

INTRODUCTION

Nursery stock producers growing plants in containers look for ways to replace part or all of the peat moss or bark in potting mixes due to the rising expenses of these components. De-inked paper sludge from recycled newsprint production is an organic waste product that may be a good substitute for bark. Our previous studies have shown that several tree species grow well in newsprint sludge-amended mixes, but one species grew poorly if grown in a mix that contained more than 40% paper sludge. Some broadleaf evergreens can be difficult to grow under normal circumstances, and paper sludge could affect the growth of these plants.

OBJECTIVE

The goal of this study was to determine if de-inked paper sludge could replace some or all of the bark in soilless potting media used for growing four evergreen shrub species.

MATERIALS AND METHODS

De-inked newsprint sludge was used in this study and was composed of discarded recycled paper fibers. Potting mixes contained 0, 20, 40, 60, 80, or 90% paper sludge (by vol.). All media contained 10% sand. In addition, all media contained 10% peat moss except the 90% sludge mix, and bark was added to bring the volume up to 100%. Initial chemical properties of the media, including pH, CEC, EC, C:N ratio and available P and K, were determined before adding preplant fertilizers. Twelve rooted cuttings of *Juniperus horizontalis* 'Youngstown', *Photinia* x *fraseri*, *Rhododendron* 'PJM', and *Daphne* x *burkwoodii* were planted in 3-liter plastic pots for each container mix. Plants were placed in a gravel container yard and grown for 19 weeks. Shrubs were watered twice daily and received supplemental fertilization with 30N-4.4P-8.3K at a rate of 75 mg/l N twice a week. At the end of the experiment, changes in plant height were determined for rhododendron, photinia and daphne, whereas changes in plant width were determined for juniper. The effects of potting mixes on the growth rates of the plants were determined by graphing the increases of average juniper width or the increases of photinia or rhododendron heights over time.

To determine bulk densities of the media, a 4-inch pot was filled with potting mix, dropped three times from a height of 10 cm (~ 4 inches) and then filled to the top with

potting mix. This quantity of potting mix was placed in an oven, dried at 105°C for 18 hours, and then weighed after cooling to room temperature. Three replicates were used for each potting mix.

Percent shrinkage of the potting mix was determined by randomly selecting four pots of each medium for the four species growing in the mix and measuring the distance from the rim of the pot to the potting mix surface. After 19 weeks, the distance from the rim of the pot to the potting mix surface was again measured. The distance measurements were converted to volumes of media. The difference between initial volume and final volume divided was divided by initial volume, and this quotient was multiplied by 100 to equal the percent shrinkage of the media. Significant differences between treatment means for bulk densities or percentages shrinkage were determined by protected Fisher's LSD test at the 5% level.

RESULTS

1. Daphne were excluded from all analyses in this study since too many plants died during the experiment, and the foliar samples had to be pooled to have enough tissue for analyses.

2. The width of the 'Youngstown' junipers increased similarly for plants in all potting mixes except the 90% sludge mix, which grew the slowest (Figure 1).

3. Rates of height growth by photinia plants grown in 40% or less paper sludge were similar, whereas the heights of those grown in 60% or more sludge increased at only about half the rate the plants in lower quantities of paper sludge (Figure 2).

4. The growth rate of rhododendron plants grown in the control mix (80% bark) was the fastest compared to any other rhododendrons grown in a potting mix containing paper sludge (Figure 3). Plants grown in potting mix containing 80% or more paper sludge media grew little if any in height.

5. In practical terms, the bulk densities of all potting mixes were similar, even though they were statistically different (Table 1). The mix made with 90% paper sludge, however, was about 38% lighter than the control medium that contained 80% bark (0% paper sludge).

6. The volumes of potting mixes made with 60% or more paper sludge shrunk by 5% or more during the experiment (Table 1). In fact, the volume of the 90% sludge mix shrunk by almost 13% during the 19-week study.

CONCLUSIONS FROM THESE DATA

1. Based on the width growth rate for 'Youngstown' juniper and height growth rate for photinia, these plants grew reasonably well in potting mixes containing 40% or less of paper sludge by volume. In contrast, height increases by rhododendron plants over the 19-week period were highest for plants grown in a potting mix without paper sludge.

2. Media amended with large volumes of paper sludge were light in weight. In general, the lighter the volume, the easier the material is to handle for nursery workers.

3. Potting mix volume shrunk in proportion to the amount of paper sludge in the medium. The amount of shrinkage increased as the volume of paper sludge used in the mix increased. Potting mix made with 90% paper sludge shrank by almost 13%, an amount that is probably unacceptable to commercial nurseries.

Table 1. Mean initial bulk density and mean percent shrinkage of paper sludge-amended media.

Medium (% paper sludge)	Bulk Density ($g \cdot cm^{-3}$)	Percentage shrinkage of potting mix volume[z] (%)
0	0.34 b[y]	- 0.1 d
20	0.32 cd	0.8 d
40	0.31 d	1.8 d
60	0.34 b	5.8 c
80	0.37 a	9.4 b
90	0.21 e	12.8 a

[z] Percent shrinkage of the initial volume of the potting mix was calculated by subtracting the final volume from the initial volume, dividing the difference by the initial volume and then multiplying the quotient by 100.

[y] Means followed by different letters with a column are significantly different at $P < 0.05$ by protected Fisher's LSD test (n = 3 for bulk density and n = 16 for percent shrinkage).

OVERALL CONCLUSIONS FROM THIS STUDY

1. Due to the low CEC of the paper sludge, sludge-amended media should contain at least 10% peat moss by volume.

2. Newsprint paper sludge may serve as a source of available P in the potting media, but softwood bark supplies large quantities of available K.

3 Plant responses to high proportions of de-inked paper sludge in the mixes were species specific. Although the width increase and rate of width increase of junipers and the height increase and height growth rate of photinia were good in media containing 40% or less paper sludge, rhododendron tolerated only up to 20% sludge in the medium. In fact, a potting mix for 'PJM' rhododendron should exclude newsprint sludge for optimum plant growth since plants grown in the control mix grew at the highest rate.

4. Based on leaf mineral nutrition, paper sludge appears to be a source of Mo and Ca, but the sludge is deficient in Mn as shown by severe deficiency symptoms on some photinia and rhododendron plants as well as daphne plants.

5. Bulk densities of potting mixes made with newsprint sludge were similar to those found in a typical nursery potting mix. Over the course of the study, however, potting mixes with the highest amounts of newsprint sludge shrank the most. Fortunately, mixes amended with 40% or less paper sludge shrank by very little if at all, and their amount of shrinkage would be acceptable for commercial use of the mixes.

Fig. 1: Juniper: Width Change over time

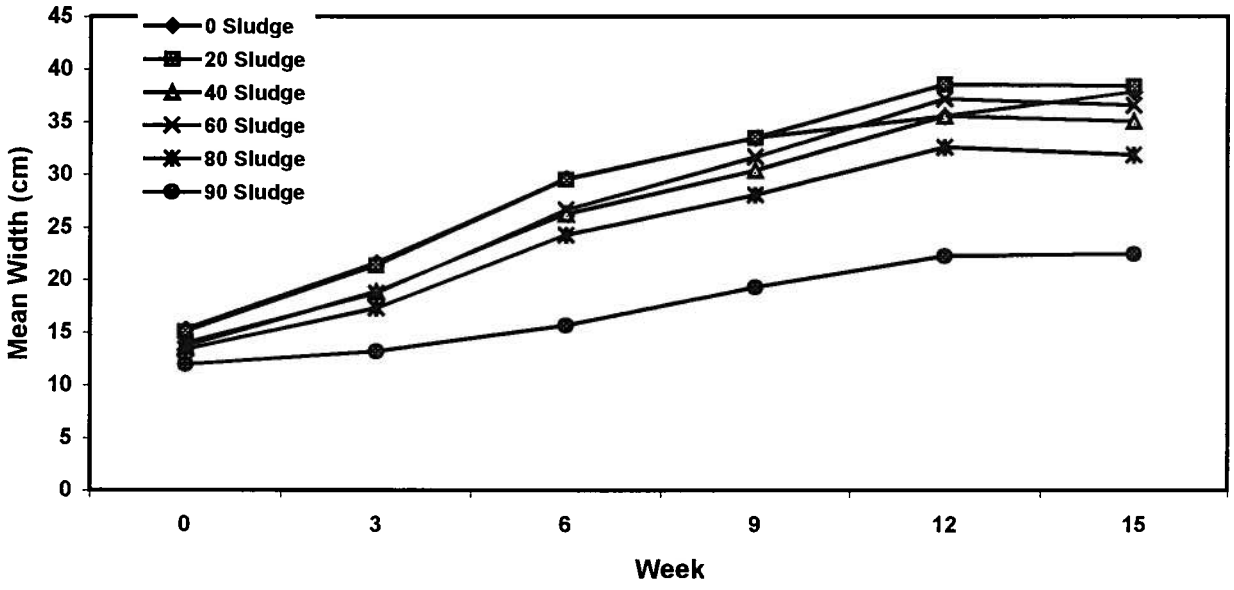

Fig. 2: Photinia: Height Change over Time

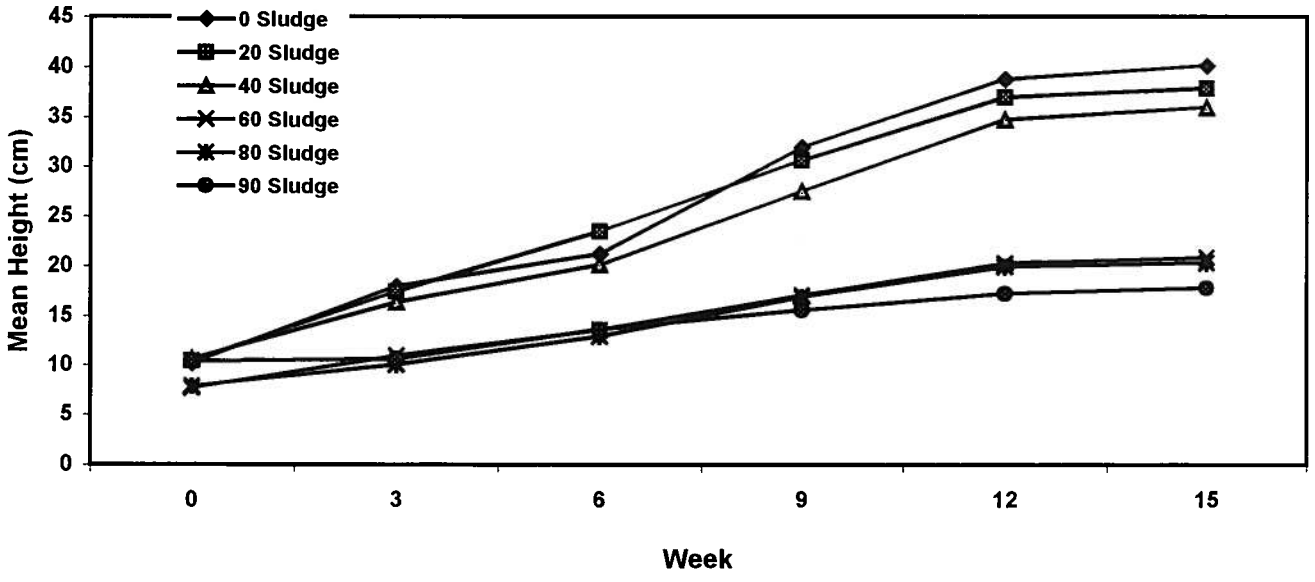

Fig. 3: PJM:Height Change over time